

The Parathyroid Hormones

ILOs:

- List the target organs for parathyroid hormone
- Summarize its effects on the target organs
- Explain how PTH secretion is regulated
- differentiate between the consequences of hypo and hyper secretion of PTH.

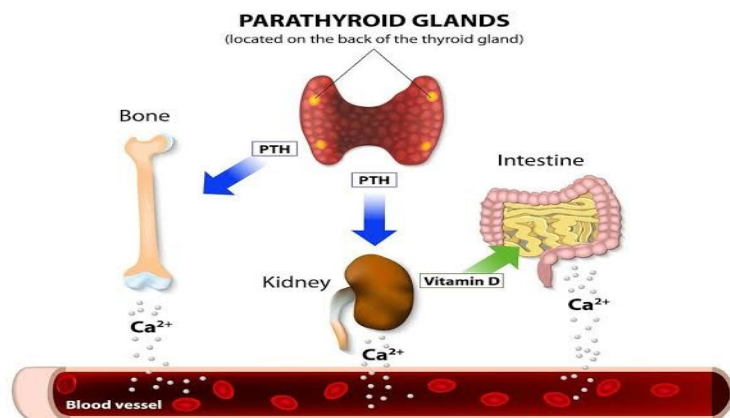
Actions of PTH

- PTH increases the plasma Ca^{2+} level and decreases the plasma PO_4^{3-} (P) level (normally 2.5-4.5mg/dL), helping to maintain the solubility product ($\text{Ca}^{2+} \times \text{P}$) constant.
 - The action is done through 3 target organs:

- **Skeleton:**

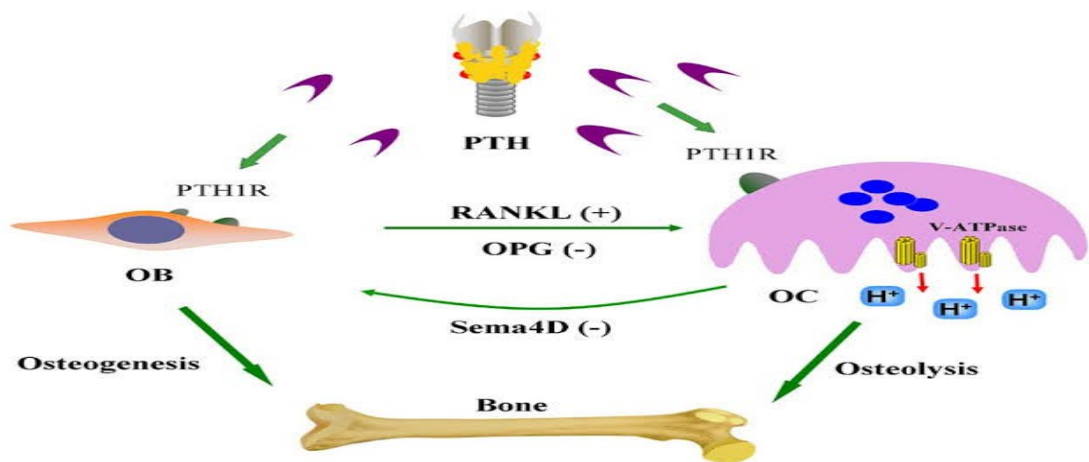
- A. Immediate:**

- increase Ca^{2+}
mobilization
from bone
within minutes
and for hours :



https://encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcRczPvDhVSWqU6rwtDW8ETWWWbj35IQHeP1Zd_Cv7T3TGNJ7Kyz

1. Mobilization of Ca^{2+} from bone fluid to ECF. PTH stimulate membrane bound Ca^{2+} pump.
 2. Active form of vitamin D increase bone responsiveness to PTH.
- **Delayed:** take days to weeks: Activation of the osteoclastic system occurs in two stages:
 1. immediate activation of the osteoclasts that are already formed
 2. formation of new osteoclasts. Several days of excess PTH usually cause the osteoclastic system to become well developed, but it can continue to grow for months under the influence of strong PTH stimulation.



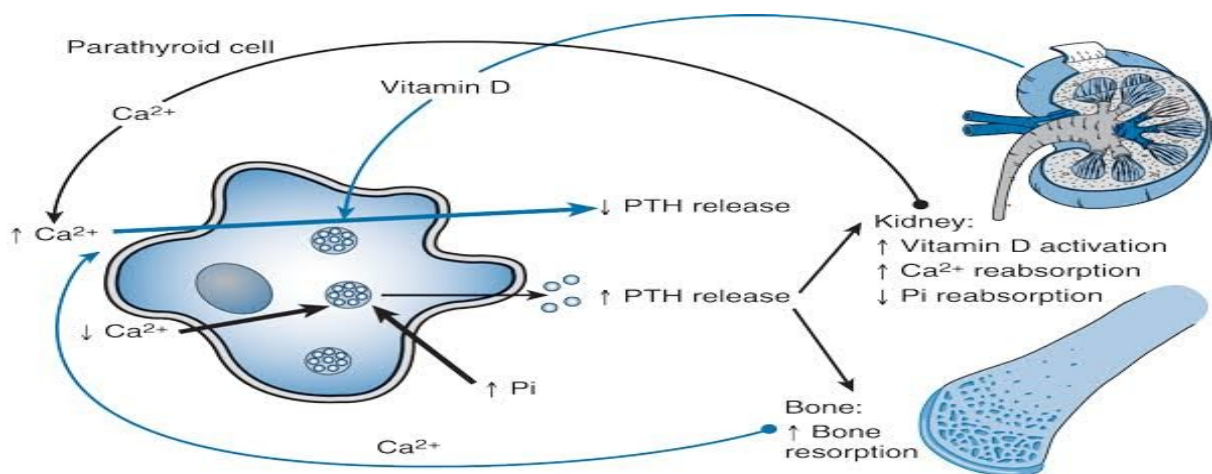
https://encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcT4y-1RkyEwViyZ0Rx4vTcyKex71PCEDC9s5ROHF_7GLXaECWPq

- **Kidneys:**
 1. Stimulate reabsorption of Ca^{2+} in the distal convoluted tubules of the kidney.

2. It decreases the plasma phosphate (P) level by helping its excretion in urine (phosphaturic action) through inhibiting its reabsorption in the proximal convoluted tubules of the kidney.
 3. Increase activation of 1, 25-dihydroxycholecalciferol (1, 25-DHCC).
- **Intestine:**
PTH greatly enhances both calcium and phosphate absorption from the intestines by increasing the formation in the kidneys of 1,25-dihydroxycholecalciferol from vitamin D.

Regulation of PTH Secretion:

1. **Plasma Ca^{2+} and Mg^{2+} levels:** These regulate PTH secretion by a negative feedback mechanism. Calcium sensing- receptors (G-protein receptor) are present in parathyroid gland cells that sense the levels of calcium in blood and accordingly increase or decrease PTH secretion. A decrease of only a fraction of mg/dl in plasma calcium concentration can double PTH secretion either in acute or chronic way. PTH secretion increase with hypertrophy of the gland occur in conditions with low calcium level in some physiologic condition as in pregnancy and lactation.



Source: Molina PE: *Endocrine Physiology*, 4th Edition: www.accessmedicine.com
Copyright © The McGraw-Hill Companies, Inc. All rights reserved.

2. **1, 25-dihydroxycholecalciferol (DHCC):** This inhibits formation of PTH.
3. **Plasma phosphate level:** increase in phosphate level cause increased PTH secretion .

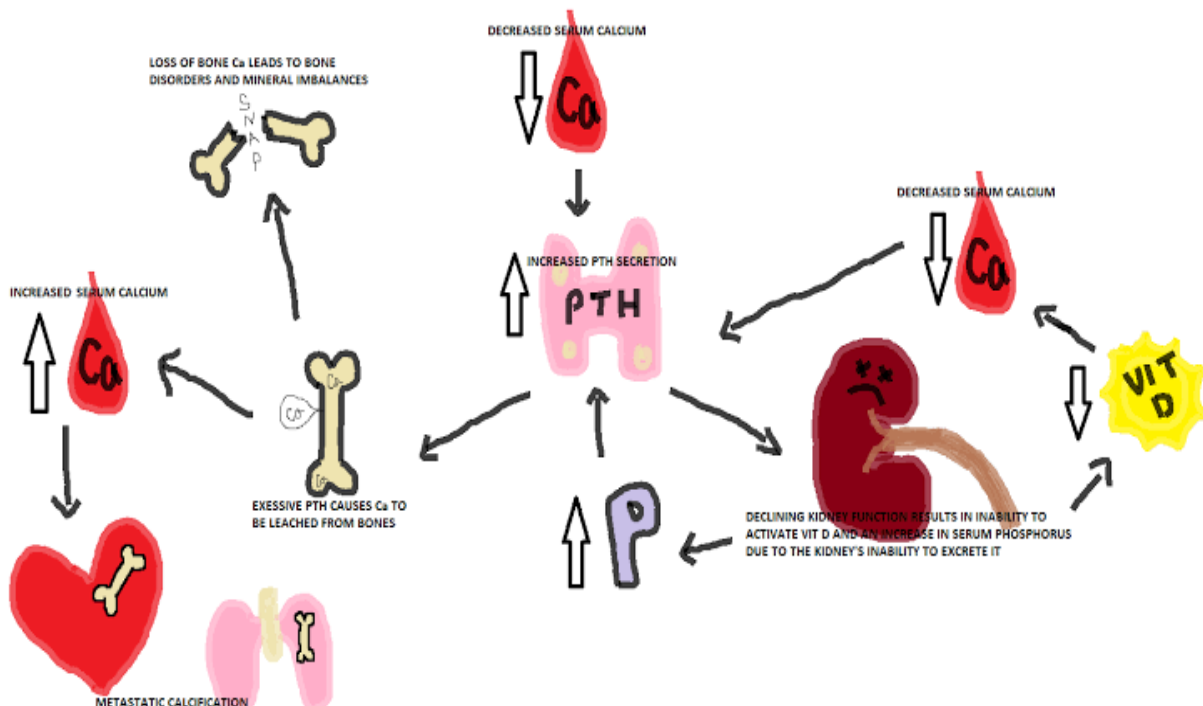
Hyperparathyroidism

Causes:

- 1) **Primary :** adenoma more common in females after pregnancy and lactation as these conditions lead to hypertrophy of the gland. The plasma calcium level rise up to 12 to 15 mg/dl.
- 2) **Secondary: *Plasma level is normalized by the effect of increased PTH secretion***
 - a) Secondary to hypocalcaemia as in rickets, osteomalacia (adult rickets) and renal failure. Vit D deficiency is the common factor causing hypocalcaemia in these conditions.
 - b) Secondary to increased phosphate level as in renal failure.

Effects:

- 1) **Bone :** increased osteoclastic activity with bone cysts and fractures (may be the 1st symptoms to drag the patient for medical advice).
- 2) **Kidney:** renal stones
- 3) **Heart:** arrhythmias and decreased heart relaxation in diastole.
- 4) **Muscle:** weakness
- 5) **GIT:** nausea and vomiting and constipation .



Hypoparathyroidism

Causes:

- ✓ Most common is surgical removal with thyroidectomy.

Manifestation:

- ✓ Hypocalcaemia which is manifested as tetany. When the parathyroid glands are suddenly removed, the calcium level in the blood falls from the normal of 9.4 mg/dl to 6 to 7 mg/dl within 2 to 3 days and the blood phosphate concentration may double. This low calcium level causes the symptoms and signs of tetany.

Tetany

Tetany is a state of skeletal muscle spasm due to an increase in neuromuscular excitability secondary to reduction of the plasma Ca^{2+} level.

Causes of hypocalcemia & tetany:

What could be the cause?

Decreased dietary intake, renal failure with hyperphosphatemia, vit D deficiency & loss of PTH.

Types of Tetany:

1. **Manifest tetany:** This occurs when the plasma Ca^{2+} level drops below 7 mg%. It is characterized by the following symptoms during rest:
 - a. Commonly the patient presents with **carpopedal spasm.**
 - b. If the respiratory muscles are involved (in severe cases), the condition may be fatal due to **laryngeal spasm** (for this reason, the parathyroid glands are essential to life).
 - c. Intestinal or biliary colic



2. **Latent tetany:** This occurs when the plasma Ca^{2+} is 7-9 mg%. The symptoms appear only during *emotions, exercise, hyperventilation* and *pregnancy*. It can be diagnosed by:
- a. Measuring the plasma Ca^{2+} level.
 - b. **Provocation tests:**
 - **Chvostek's sign:** Tapping over the facial nerve at the angle of the mandible produces a quick contraction of the ipsilateral facial muscle.
 - **Trousseau's sign:** Occluding the circulation in the upper limb for few minutes (by a sphygmomanometer cuff) produces the characteristic carpal spasm.

Treatment of tetany

1. I.V. injection of calcium gluconate during the acute attacks (very slowly).
2. Giving vitamin D injection and calcium-rich diets.
3. Treatment of the cause.